AFRICAN UNION
INTERAFRICAN BUREAU
FOR ANIMAL RESOURCES

The Post Rinderpest Eradication Strategy

Picture cover page:

Celebrating Kenya's freedom from Rinderpest

The President of the Republic of Kenya, HE Mwai Kibaki (second from left, front row) unveils, in November 2010, the commemorative statue in Meru National Park, where the last case of Rinderpest was reported in 2001.

Looking on from left to right, front row: Prof. Ahmed El-Sawalhy, Director AU-IBAR, Mr. Eric van der Linden, Head of the EU Delegation to Kenya, Dr. W.N. Masiga, the OIE Sub-Regional Representative for Eastern and the Horn of Africa and Hon. Mohammed Kuti, the Minister for Livestock Development of Kenya. Also looking on, behind the AU-IBAR Director, are, from left to right, Dr. Julius Kipng'etich, Director of the Kenya Wildlife Service and Dr. Peter Ithondeka, Director of Veterinary Services Kenya. Looking on at the extreme right is Mr. C. Camarada, the FAO Sub Regional Coordinator for Eastern Africa.

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LIST OF ABBREVIATIONS AND ACRONYMS

AU	African Union
BSL	Bio Safety Level
BVD	Bovine Virus Diarrhoea
CAHWs	Community Animal Health Workers
CBPP	Contagious Bovine Pleuro-pneumonia
CCPP	Contagious CaprinePleuro-pneumonia
CCTA	Commission for Technical Cooperation in Africa South of the Sahara
cDNA	Complementary DeoxyRibo-Nucleic Acid
CVO	Chief Veterinary Officer
EAC	East African Community
ECCAS	Economic community for Central African States
ECOWAS	Economic Community of West African States
EHD	Epizootic Haemorrhagic Disease
EIDs	Emerging Infectious Diseases
ELISA	Enzyme-Linked Immunosorbent Assay
FAMA	Foundation for Mutual Assistance in Africa South of the Sahara
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot and Mouth Disease
GHA	Greater Horn of Africa
GIS	Geographic Information System
IAEA	International Atomic Energy Agency
IBAH	Inter-African Bureau of Animal Health
IBAR	Interafrican Bureau for Animal Resources
IBR	Infectious Bovine Rhinotracheitis
IGAD	Intergovernmental Authority on Development
ILRI	International Livestock Research Institute
IRCM	Integrated Regional Coordination Mecahnism
MCF	Malignant Catarrhal Fever
NGO	Non Governmental Organization
OAU	Organization of African Unity
OIE	Office International des Epizooties/World Organization for Animal Health
PACE	Pan African Programme for the Control of Epizootics
PANVAC	Pan African Vaccine Centre
PARC	Pan African Rinderpest Campaign
PDS	ParticipatoryDisease Search
PPR	Peste des Petits Ruminants

REC	Regional Economic Community
RNA	Ribo Nucleic Acid
RVF	Rift Valley Fever
SADC	Southern Africa Development Community
SERECU	Somali Ecosystem Rinderpest Eradication Coordination Unit
SES	Somali Ecosystem
STRC	Scientific and Technical Research Council
TAD	Transboundary Animal disease
UNICEF	United Nations Children's Fund
WTO	World Trade Organization

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AU-IBAR would like to take this opportunity to thank and express its appreciation to the International Livestock Research Institute (ILRI) for the input and review of this Post Rinderpest Eradication Strategy.

EXECUTIVE SUMMARY

This document presents the post Rinderpest eradication strategy developed by AU-IBAR for the mitigation of the risk of the re-emergence of Rinderpest in Africa. The document begins with a brief summary of the Rinderpest eradication process in Africa and the lessons learned. This is followed by a qualitative analysis of the risk of re-emergence of the disease. Finally, the post-Rinderpest eradication strategy for the mitigation of the risks identified in the analysis is presented.

Several factors envisaged in the post-Rinderpest eradication era indicated the need for a risk analysis to determine the level of risk of Rinderpest re-emergence and the subsequent development of a corresponding strategy to mitigate the risk. These factors include:

- Weak animal disease surveillance and reporting systems;
- Existence of Rinderpest virus in laboratories with weak biocontainment procedures;
- Non-availability of vaccines and loss of vaccine production capacity and capability;
- Rapid erosion of Rinderpest response capabilities;
- Rapid loss of institutional memory with regard toRinderpest expertise from the veterinary services;
- Historical examples of failure to rapidly detect and contain small foci of Rinderpest infection;
- The responsibility of the veterinary profession to safeguard a world which has become more Rinderpest vulnerable due to increased susceptible population.

Risk is defined as the probability of the event occurring and the consequences of the event. Descriptive risk analysis has identified several hazards for Rinderpest re-emergence such as the potential existence of sub-clinical/mild disease, threats from laboratory stocks of Rinderpest virus, retention and possible use of live attenuated Rinderpest virus vaccines and the emergence of new pathogenic morbilliviruses. For the most part, the probability of Rinderpest re-emergence as a result of these hazards was considered very low to negligible. However, the consequences of the re-emergence of Rinderpest in an otherwise Rinderpest free world lacking surveillance and response capability would be considered catastrophic.

The risk analysis concluded that there is no evidence that Rinderpest still

persists as a sub-clinical or mild disease anywhere in Africa. Thus, the risk of virus persistence in nature was considered negligible. Natural field strains of the virus stored in laboratories in pathological specimens or as cultured isolates, were considered the greatest risk. As this risk is entirely man-made, it was considered that committed action could successfully reduce this risk to a negligible level. The mitigation strategy does not identify any valid reason for the continued retention of the Rinderpest virus containing materials at the national level in Africa and recommends that Rinderpest virus materials be destroyed or sequestered at the AU-PANVAC laboratory (if they must be retained at all), as recommended during the 8th Conference of Ministers responsible for animal resources in Africa that was held in Entebbe Uganda on 13th and 14th May 2010. The threat that a new morbillivirus or an existing morbillivirus such as PPR virus may evolve and give rise to a new morbilllivirus disease is difficult to quantify but merits continued research and surveillance.

The mitigation strategy organises actions into four elements. These are actions to:

- Better understand and quantify risk;
- Reduce the probability of re-emergence;
- Enhance detection of re-emergence;
- Enable rapid containment and eradication of any re-emergence.

The post eradication strategy will reduce the risk of re-emergence through effective, supervised and verified sequestration of the Rinderpest virus and virus-containing materials, including vaccine stocks and diagnostic test kits.

The strategy will also enhance capacity for early detection of re-emergence through inexpensive, sensitive and practical surveillance systems that will be based on a syndromic disease surveillance approach. The surveillance strategy targets important diseases based on four syndromes, namely, a stomatitis-enteritis syndrome, a pneumonia syndrome to capture pleuro-pneumonias, an abortion syndrome to address zoonotic diseases like brucellosis and Rift Valley fever and a haemorrhagic syndrome which captures the emerging bovine haemorrhagic bowel syndrome and bovine calicivirus enteritis.

The strategy seeks to maintain and strengthen response capacities through national and international Rinderpest contingency plans, quality-assured vaccine banks and diagnostic capacity building. Coordination and integration of these activities to assure rapid response to disease re-emergence is

emphasised. Similarly the need for synergy and cooperation with other relevant international organizations such as FAO and OIE and NGOs is considered essential. It is hoped that this document will be useful to veterinary services in African countries, African regional organizations, academic and research institutions as well as technical and development partners.

INTRODUCTION

Until recently, Rinderpest, a highly infectious viral disease of even-footed ungulates of the order Artiodactyla, was the most dreaded of all African cattle diseases. Just over 100 years ago, it was introduced to the African continent through the Ethiopian became a contributing factor to the Great Ethiopian Famine) and from there to east, south and west Africa as a near continent-wide pandemic associated with massive losses of both domestic and wildlife populations as well as severe human hardship.

Through a combination of stringent zoosanitary controls and the extensive use of a prophylactic method based on the simultaneous administration of Rinderpest immune serum and live Rinderpest virus (the serum-simultaneous vaccination method), it was possible to eliminate the virus from southern Africa in a relatively short period. In the aftermath of the great pandemic, for many years, the cattle populations of sub-Saharan Africa remained endemically infected providing a background from which further local epidemics could arise. In contrast to the earlier successes in southern Africa, neither colonial nor newly independent veterinary services were able to do more than control the incidence of the disease across this enormous tract, mainly due to difficulties in controlling the sanitary movement of (infected) nomadic livestock. This situation did not change signalling the need for a concerted effort of transnational co-operation.

CONTROL AND ERADICATION OF RINDERPEST IN AFRICA

In 1948 an African Conference on Rinderpest was held in Nairobi, Kenya that recommended the creation of an African Rinderpest Bureau, although this had to await the establishment of the empowering Commission for Technical Cooperation in Africa South of the Sahara (CCTA) and the Foundation for Mutual Assistance in Africa South of the Sahara (FAMA) in 1950. The Bureau was launched in 1952 as the Inter-African Bureau of Animal Health (IBAH). In 1970 this body broadened its responsibilities to include animal production and was renamed the Interafrican Bureau for Animal Resources (IBAR). In 1964 Heads of State of the emergent Organisation of African Unity (OAU) determined that the CCTA would become the Scientific and Technical Research council (STRC) of the OAU with IBAR as one of its specialised units.

Given the growing understanding among Directors of Veterinary Services of the need for concerted action against Rinderpest the OAU/STRC and IBAR moved to start a joint, inter-African campaign supported by Member States and International Development Partners aiming to eradicate Rinderpest

through mass vaccination. This first attempt, Joint Project 15 (JP15), (1962-1976) developed a strategy based on three consecutive rounds of annual mass vaccinations in a series of phases involving different national veterinary services at different times followed by annual vaccinations by individual countries of calves and weaners. By the end of 1979, only Sudan out of the 22 participating countries reported the continued presence of Rinderpest. Had JP15 adopted a more targeted vaccination strategy aimed at achieving a defined and verifiable epidemiological end-point, Rinderpest may indeed have been eradicated during this period. The near eradication of Rinderpest by JP15 resulted in a rapid build-up of susceptible cattle populations that created ideal conditions for the re-emergence of Rinderpest and the Second African Pandemic. The re-emergence of Rinderpest after the end of JP15 was a historical lesson that highlighted the need to see global eradication through to its completion and the necessity of a post eradication strategy.

The second continental campaign against Rinderpest, the Pan African Rinderpest Campaign (PARC), was operational between 1986 and 1999 and was active in 35 countries. It was designed to provide emergency relief to several badly affected countries followed by protective vaccination in the remaining participating countries. Some of the innovative measures that were adopted during the PARC programme were the development of a communication component, the development of a thermostable Rinderpest vaccine, institutional changes to encourage private veterinarian and community participation in vaccination and surveillance, sero-monitoring to evaluate post-vaccination herd immunity levels, establishment of laboratory networking for sero-epidemiological surveillance and the establishment of emergency vaccine banks.

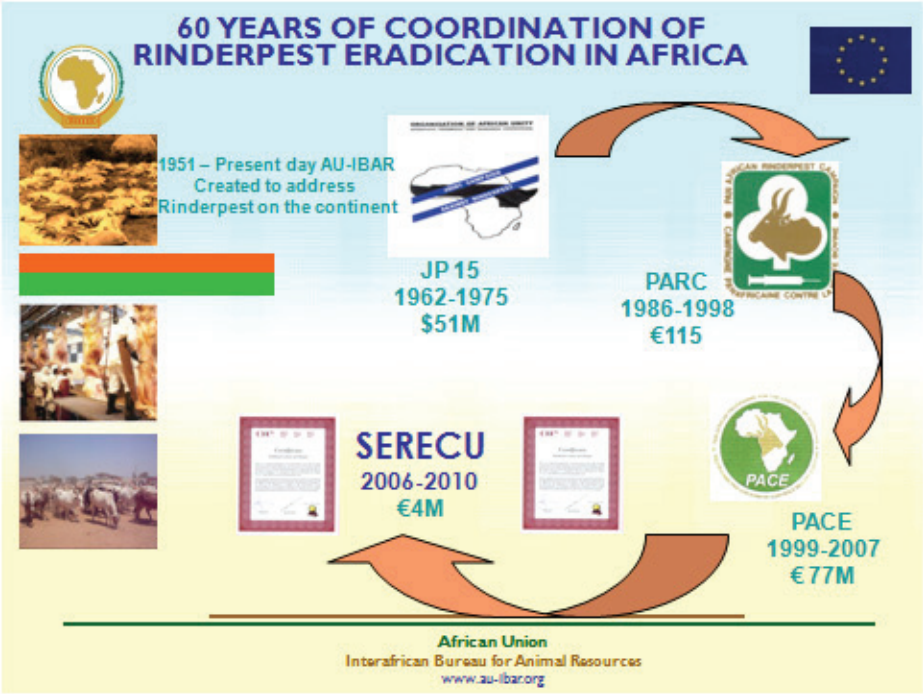
Mindful of the fact that the shortcomings of JP15 including the lack of clear objectives and a process for evaluating the completion of Rinderpest eradication directly contributed to the second pandemic, the OIE in 1989 provided a set of guidelines, the OIE Pathway, which allowed a previously Rinderpest-infected country to be recognised as Rinderpest-free with that status being internationally recorded. PARC fostered and promoted this protocol although it could only be activated once a country was sufficiently confident that vaccination under PARC had controlled Rinderpest to the point that it was willing to stop vaccination and engage in surveillance measures that would prove that the virus was no longer circulating by declaring provisional freedom from the disease.

As at the end of PARC in 1999, only 16 African countries had embarked on

the OIE pathway by declaring provisional freedom from Rinderpest. This was essentially because PARC member countries were somehow still hesitant to stop vaccination and move to surveillance even though, in West Africa at least, Rinderpest had not been seen in more than 20 years. Effectively then, the number of years of possible surveillance was limited by the continuation of vaccination. Although it took two rounds of international cooperation in the costly mass application of vaccine to reach a point where Rinderpest was no longer visible as a disease, a key lesson from the JP15 experience was that there was a real need to verify apparent success by the development of a substantial volume of technical surveillance data.

By the end of PARC, Rinderpest had been eliminated from most of the western and central African countries and the last two endemic foci were perceived to be in southern Sudan and the Somali Ecosystem (comprising of parts of Somalia, Kenya and Ethiopia). Therefore AU-IBAR with EU financial support instituted another programme, the Pan African Programme for the Control of Epizootics (PACE) to manage the final eradication of Rinderpest building on the success of PARC. The PACE programme ran from 1999-2007 and involved 32 African countries. While targeting Rinderpest, PACE was also designed to improve the technical and physical resources and capacity of participating national veterinary services to diagnose and quantify the impact of major transboundary animal diseases (TADs) and consequently mount effective control strategies. Some of the achievements of PACE included the operationalization of active disease surveillance including participatory disease search, the use of CAHWs in difficult terrains and situations, formation of epidemiological networks, capacity building for diagnosis of Rinderpest and other important TADS such as FMD, CBPP and PPR and inclusion of wildlife in national animal disease surveillance programmes. At the end of the programme, Rinderpest had been eliminated from southern Sudan, with the only foci remaining in the Somali ecosystem.

Consequently AU-IBAR conceptualized the Somali Ecosystem Rinderpest Eradication Coordination Unit (SERECU) with an aim of developing a strategic plan for eventual verification of freedom from Rinderpest in the SES countries in consonance with the OIE pathway. The programme led to Ethiopia gaining accreditation of freedom from Rinderpest in 2008, Kenya in 2009 and Somalia in 2010.



The fight against Rinderpest - a story that begins with JP15 and ends with SERECU

Lessons learnt during the Rinderpest eradication programmes

A number of lessons were learnt during the above mentioned eradication programmes that have informed the development of a post eradication era strategy for Africa. These include:

- Rinderpest eradication required sustained political goodwill at the national, regional and global levels especially when disease impact diminished with time.
- The AU-IBAR leadership role was critical in bringing together key stakeholders and political leaders for the implementation of focused and objective action plans.
- AU-IBAR's partnership with FAO, OIE and IAEA to provide leadership on institutional reforms such as vaccination delivery by private veterinary professionals Community Animal Health Workers (CAHWs) and the use of Participatory Disease Search (PDS) in animal health delivery played an im-portant role in eradication efforts.
- Epidemiological targeting of control activities increased the impact of interventions and facilitated the completion of eradication.

- Research which helped clarify that wildlife species are not carriers of the Rinderpest virus contributed to the success of Rinderpest eradication.
- An ecosystem approach with enhanced coordination and harmonization between veterinary services of neighbouring countries was very critical for concerted efforts in the eradication of the disease.

THE RISK OF RINDERPEST RE-EMERGENCE

Notwithstanding the OIE-FAO declaration of global freedom from Rinderpest in June 2011, AU-IBAR is mindful of the consequences of failing to detect any residual foci of infection in Africa. It is also aware of the enormity of the investments made by national veterinary services and donors to reach a point where the continent has been restored to the Rinderpest-free state it enjoyed more than a century ago. Nevertheless, the livestock disease surveillance systems in Africa remain weak and, mindful that the high surveillance standards attained under PACE may not have been maintained during the last five years, AU-IBAR wishes to safeguard the continent against any disaster by attempting to restore those standards. At the same time, many African countries wish to add value to their livestock and livestock products through the development of export markets. However, international movement of livestock, meat and other livestock products is now subject to standards of disease control developed by OIE and regulated by WTO which require that these animals and products emanate from countries and/or zones with acceptable levels of risk for disease/infection transmission. Ideally, they should be internationally recognized as free from certain diseases through negative results of auditable surveillance data. Furthermore, countries and development partners look forward to supporting livestock disease control programmes that do not tackle only one disease, as was the case with Rinderpest, but have the objective of controlling diseases more generally, and in this respect, of particular importance are those which interfere with the export trade of livestock and their products and those with high impact on food security. Another goal of development partners is to establish surveillance to enable timely control of emerging infectious diseases (EIDs) that affect animal and human populations. Changes in ecosystems due to population growth, economic development, intensification of farming as well as demand for and production of animal food, intensification of trade, movement of people and goods and climate change are reshaping disease threats and require the world to adapt in preventing, detecting and responding to new disease risks. EID events are dominated by zoonoses (60.3% of known EIDs): the majority of these (71.8%) originated in wildlife and they are increasing significantly over time (Jones *et. al,* 2008). The past decades' increase in emergence or re-emergence of infectious diseases,

mostly coming from animals and due to the ecosystem changes (Garrett 2005, De Salle 1999, Gibbs 2005, Glenn *et. al.* 2008), call for a more integrated approach to these components.

Closer interaction between domestic and wild animals poses risk of disease emergence.

Buffaloes are susceptible to Bovine TB, FMD and RP

Descriptive risk analysis of the residual threat of Rinderpest

The criteria specified in the OIE Pathway for declaration of freedom from Rinderpest infection considers the risk of continued existence of Rinderpest as neglected in countries that followed the Pathway. Each and every country in the world has complied with the OIE Pathway. This comprehensive, evidenced-based process ruled out speculation that Rinderpest might have the capability to persist in nature as subclinical/mild disease (Roeder *et al.,* 2006; Taylor, 1986) and led to the global declaration of eradication.

As a result, the report of the Joint FAO/OIE Expert Committee on Rinderpest based on information and data from FAO, OIE and AU-IBAR, confirmed that circulating Rinderpest virus had been eliminated from the world including the SES countries that were regarded as the last foci of mild disease. The report observed that the major threat with regard to resurgence of the disease lies with live pathogenic and attenuated viruses held in different laboratories in the world. Several years have now elapsed since the cessation of Rinderpest vaccination in Africa and most cattle populations on the continent are expected to be susceptible. It is known that a small percentage (~10% in some locations) of the cattle population was seropositive for PPR and immune to Rinderpest. This information shows that other morbillivirus do enter cattle and could offer an evolutionary pathway to new morbillivirus pathogens of cattle. Although the above risk is very low, the consequences of such an event would be very significant. A science-based strategy for the mitigation of the risk of the re-emergence of Rinderpest or other morbilliviruses in cattle is required.

Perceived hazards/threats from pathogenic RP viruses

The report of the joint FAO/OIE expert committee on Rinderpest identified the presence of live pathogenic virus in many national and regional laboratories as the major threat to Rinderpest re- emergence. Factors that may increase the chances of cattle being exposed and infected from these sources include poorly controlled laboratories and unsupervised use of virus or virus-containing materials in research trials, accidental release of materials from the laboratories or wilful release by disgruntled employees (bio-terrorism and bio-omission) especially in situations where cattle populations exist close to laboratories that handle Rinderpest pathological specimens.

Perceived hazards/threats from attenuated RP viruses

Similarly, vaccine stocks may remain deep frozen in national, regional or field veterinary laboratories. While vaccine strains of virus pose less of a risk for the re-emergence of Rinderpest disease, there has been some evidence that, very rarely, vaccine strains of Rinderpest virus may revert to virulence. There is no concrete evidence that the live tissue culture attenuated Kabete "O" vaccine strain of Rinderpest virus (Plowright and Ferris, 1962) ever reverted to virulence but it cannot be ruled out. There has been no resolution of the various reports of Kabete 'O' gene sequences from samples taken from sick animals in East Africa. One of the reports relates to an outbreak in Tanzania in the course of which 13 animals died suggesting that reversion of a vaccine strain to virulence could have been one possible explanation.

There has been speculation that vaccine strains pose a risk of reversion to virulence as they were not cloned at the time of their development. Therefore, a vaccine could be composed of viruses of varying pathogenicity in which viruses with very low pathogenicity, selected by the attenuation process, predominate. It has been proposed that if the vaccine has been subjected to improper storage, or mishandled in some way, the opportunity might arise for selection of virulent virus at the expense of the mild strains in the vaccine. In addition, experimental studies by Plowright showed that the tissue culture attenuated Kabete 'O' strain of Rinderpest virus could regain virulence when back-passaged in susceptible cattle (Plowright and Ferris, 1962). There is also a possibility of the Rinderpest virus being present as an adventitious agent in other vaccines for controlling cattle diseases. The obvious strategy is to destroy all Rinderpest viruses and virus containing materials and to hold Rinderpest vaccines and vaccine seeds in a well-secured centre in Africa.

Threats to cattle from other morbilliviruses

Theoretically, there is a possibility of PPR evolving to become a pathogen of cattle or one of several wildlife species (Dorcas gazelle, Gemsbok, Laristan sheep and Nubian ibex) which have been reported by Furley *et al.,* (1986) to be also susceptible. The emergence of novel morbilliviruses must also be considered. In this respect, the southward spread of PPR virus currently occurring in Africa and the risk of it establishing itself in species other than sheep and goats (e.g. large ruminants and wildlife) needs to be considered. The risk of other morbilliviruses establishing in cattle just as canine distemper virus has established in lions may add to this fear. It has been speculated that when animal and human populations reached a critical size some sort of proto-Rinderpest virus evolved to become Rinderpest and possibly spread to humans to become measles. It is not known if any such proto-morbillivirus still exists and could re-evolve into a pathogen for cattle, or whether an existing fully evolved morbillivirus virus such as PPR could assume the same role. At the present time there is no understanding of any incidence of non-Rinderpest, non-PPR morbillivirus infections in cattle in Africa but what is almost certain is that for the first time ever, the world large ruminant population is susceptible to Rinderpest.

In addition, there may be as yet unrecognised morbilliviruses circulating in African livestock populations, the dissemination of which had been blocked by previous Rinderpest vaccination, and which could exploit the niche created by Rinderpest susceptible cattle. Factors that may increase or decrease the likelihood of this happening are poorly understood. There is need to carry out studies during the post Rinderpest eradication era on other morbilliviruses in cattle populations. Should results of such studies indicate the existence of novel morbilliviruses, similar and timely actions as were carried out for Rinderpest eradication should be undertaken. In addition, within the proposed strengthening of a laboratory network in West and East Africa, a collaborative monitoring project should be undertaken with the FAO/AIEA joint division to ensure the existence of reference facilities and back-stopping within each network.

Other threats considered and disregarded

A ‘hypothetical’ threat that Rinderpest virus may persist in affected and recovered cattle has been considered and discarded. This is contrary to the accepted view that immune responses of recovered animals totally eliminate the virus (as shown by many pathological studies in the 1960s), but viral RNA has been said to persist in recovered animals providing periodic expression

Table 1: Summary of Descriptive Risk Analysis for Rinderpest Re-emergence in Africa

Hazards	Conditions for Occurrence	Level of Risk	Mitigation
The release of a pathogenic Rinderpest virus strain from a laboratory facility	• Poorly controlled laboratories and unsupervised use of virus or virus-containing materials in research trials, accidental release of materials from the laboratories or willful release by disgruntled employees (bio-terrorism and bio-omission)	High	Destroy all Rinderpest viruses and virus containing materials (Sequestration of all Rinderpest virus containing materials at AU-PANVAC)
The release of an attenuated RP strain that could revert to virulence	• Poorly controlled laboratories and unsupervised use of virus or virus-containing materials in research trials, accidental release of materials from the laboratories or willful release by disgruntled employees (bio-terrorism and bio-omission)	Low	Destroy all Rinderpest viruses and virus containing materials and to hold vaccine/vaccine seeds at AU-PANVAC
The emergence of a new morbillivirus disease of cattle and wildlife	• Known morbilliviruses such as PPR may evolve to become a pathogen of cattle or one of several susceptible wildlife species. • Existing unrecognised morbilliviruses circulating in African livestock populations emerge as pathogens	Negligible	Develop appropriate surveillance strategy and develop early detection and rapid response capabilities

Hazards	Conditions for Occurrence	Level of Risk	Mitigation
	for cattle. • A novel morbillivirus may emerge as a pathogen of cattle		
The potential existence of sub-clinical/ mild disease	• Undetected residual foci of mild disease	Negligible	Develop appropriate surveillance strategy and develop early detection and rapid response capabilities
Overall risk of RP re-emergence		Very Low	All

of an antigen which gives continued stimulation to the immune system which may explain why one successful vaccination of an animal provides lifelong immunity. There is no evidence to support this speculation and in 2012 it is unlikely that any significant numbers of recovered cattle are still alive.

Conclusion

As was concluded by the FAO/OIE declaration on global freedom from Rinderpest in June 2011 (FAO 2011), there is no evidence that Rinderpest still persists as a sub-clinical or mild disease anywhere in Africa.

The three principal threats are:

- The release of a pathogenic Rinderpest virus strain from a laboratory facility;
- The release of an attenuated Rinderpest virus strain that could revert to virulence;
- The emergence of a new morbillivirus disease of cattle and wildlife;

In regard to the emergence of a new disease, three principal mechanisms should be considered:

- A known morbillivirus such as PPR may evolve to become a pathogen of cattle or one of several susceptible wildlife species;
- An existing unrecognised morbillivirus circulating in African livestock populations emerges as a pathogen of cattle;

- A novel morbillivirus may emerge as a pathogen of cattle.

Based on the results of risk assessment of Rinderpest re-emergence and the lessons learnt during various eradication efforts in Africa, it is highly desirable that a post Rinderpest eradication era strategy be developed with emphasis on prevention of re-emergence by virus sequestration, an appropriate and sustainable disease surveillance system that would address the multiple objectives of early detection of any recurrence of Rinderpest or emergence of disease threats, global and national contingency planning and a coordination structure for rapid response. A post Rinderpest eradication strategy combining these components is described below.

THE POST RINDERPEST STRATEGY

In proposing this strategy, consideration was given to results of risk assessment of Rinderpest re-emergence as well as lessons learnt during control programmes in Africa about how best to manage animal health activities and control disease events.

The essential components of a post Rinderpest strategy for Africa include actions to:

- Better understand and quantify the risk of re-emergence;
- Reduce the probability of re-emergence;
- Enhance detection of re-emergence;
- Enhance response capacity to contain and eradicate any re-emergence.

Understand and quantify risk of re-emergence

The post Rinderpest strategy recognizes the need for continued epidemiological research, surveillance and monitoring of moribillivirus infections in livestock and wildlife in Africa. To this end, efforts to launch a coordinated program for the progressive control of PPR will be supported as a means to maintain capacity for the monitoring of morbilliviruses in Africa. These efforts should incorporate activities on the molecular epidemiology to monitor the evolution of morbilliviruses.

Reduce the probability of re-emergence through virus sequestration

As laboratory escape is considered the most significant risk, the most effective way to minimize the probability of re-emergence is to reduce the number of laboratories holding Rinderpest virus and to assure that those that do retain the virus follow best practices in terms of securing remaining stocks. Processes for

Training in the use of equipment at KWEVEVAPI in Kenya.

reviewing research plans that include the Rinderpest virus and in supervising research involving the Rinderpest virus are needed at the global level to ensure that risks of escape are minimized. However, following the eradication of Rinderpest, there is no apparent justification for any national facility to retain Rinderpest virus stocks or undertake research that utilizes the Rinderpest virus.

Rinderpest virus sequestration to prevent re-emergence of disease is to be coordinated by FAO/OIE in accordance with the guidelines contained in the resolutions of the 79th General Session of the World Assembly of Delegates of the World Organisation for Animal Health (OIE) in May 2011 in Paris. It provides guidelines/prescriptions for destruction by FAO/OIE Member Sates of Rinderpest virus-containing materials, including field and laboratory strains, vaccine strains, clinical materials from infected or suspect animals, diagnostic materials containing or encoding live virus including virus RNA or cDNA, recombinant morbilliviruses (segmented or non-segmented) containing unique Rinderpest virus nucleic acid or amino acid sequences and full length genomic materials including virus RNA and cDNA copies of virus. Where any country would wish to keep its stock of virus or virus containing materials, such countries should transparently audit and manage such stocks/materials under

biologically secure facilities. The on-going OIE/FAO Rinderpest re-occurrence risk analysis would be expected to establish a database of retained Rinderpest virus strains including vaccines and possible infectious material.

AU-IBAR considers that as far as Africa is concerned, the risk of an escape from national virus holding facilities should be reduced to a negligible level by a continent-wide policy of non-retention of Rinderpest viruses and virus containing materials.

If this cannot be agreed, AU-IBAR recommends that African countries wishing to retain their virus stocks should sequestrate such virus or virus containing materials in AU PANVAC BSL3 level facility for safe keeping subject to inspection and control of FAO/OIE/AU-IBAR. This will be in line with the recommendation of the 8th Conference of Ministers Responsible for Animal resources in Africa.

AU-IBAR recommends that FAO/OIE consultants physically and technically assist countries with the destruction, sequestration, transparent auditing of virus and virus-containing holdings and disinfection of virus holding facilities. Standard operating guidelines should be made available by FAO/OIE.

Despite the above provisions, there is a possibility, be it remote, that Rinderpest virus may continue to exist within national high security research laboratories where the existing stocks will be regarded as national property and come under the responsibility of the appropriate national authority.

In Africa, universities and research institutes that do not come under the supervision of veterinary services and enjoy relative autonomy in their research activities may have Rinderpest materials that they are reluctant to destroy or sequester at an international facility. AU-IBAR recommends that Member State Ministers bring issues relating to Rinderpest virus sequestration to the attention of national regulatory bodies for universities and research institutes such as the Ministries of Higher Education or the National Universities Commission or their equivalents to request strict compliance. If this approach does not succeed in removing the threat, new legislation or appropriate regulation should be enacted.

With regard to Rinderpest vaccine, AU-IBAR recommends that an international vaccine bank be maintained by AU-PANVAC for five years. After this period, only vaccine seed would be held in a level 3 biosecurity facility in PANVAC for use whenever needed by Member States. National vaccine banks should not

be permitted.

In their present configuration, the competitive and immuno-capture Rinderpest ELISA kits with whole virus controls are no longer acceptable in Africa in the post Rinderpest eradication era. Therefore, these antigens need to be replaced with materials made with recombinant protein technology which present negligible risk. AU-PANVAC would partner with the FAO/IAEA joint Division, the FAO World Reference Laboratory for Rinderpest, Pirbright and ILRI to promote production of new generation diagnostic kits that do not require the use of live virus.

On a global level, FAO/OIE is requested to maintain a single inventory of facilities holding Rinderpest virus-containing materials including vaccine stocks as well as develop a mechanism to facilitate and standardize reporting of Rinderpest virus-containing materials by veterinary authorities. The FAO-IAEA Joint Division (Vienna) should develop international holdings and Rinderpest sequences database. In the event of a virus escape the database will help to pinpoint the source of the problem. It is expected that, in support of the international community, FAO and OIE will ensure the maintenance of an international Rinderpest reference laboratory capable of providing confirmation of any suspect samples submitted to it and by virtue of sequence analysis, of pinpointing the most likely source of infection. In partnership with AU-IBAR, FAO and partners should also establish as soon as possible the proposed FAO/OIE Rinderpest advisory committee.

Enhancing detection of re-emergence through better disease surveillance

Various disease surveillance systems were put in place during the eradication of Rinderpest to collect data for verification of freedom from disease and infection. These included passive livestock and wildlife disease surveillance, market surveillance, structured sero-surveillance, participatory disease surveillance, risk modelling and zero-reporting.

Passive surveillance

Passive livestock and wildlife surveillance is initiated by livestock owners and wildlife park personnel with reports of ill-health or die-offs being sent to the veterinary officials for investigation including sample collection for laboratory diagnosis. While passive disease surveillance is relatively inexpensive and has the potential for wide coverage, under reporting may sometimes reduce its value.

National authorities should improve both passive livestock and wildlife surveillance by increasing the participation of the diverse stakeholder groups involved in livestock production and livestock industries as well as wildlife conservation and tourism industries. This includes groups such as livestock workers, community animal health workers (CAHWs), local traditional medicine experts, pastoralists, village chiefs, wildlife rangers, safari park drivers and researchers. The best way to achieve this is to establish regular communication and reporting channels.

It is highly desirable to increase their recognition of other priority diseases that may be confused with Rinderpest as well as awareness of the importance and value of disease reporting. AU-IBAR with partners would assist member states through the RECs to develop improved protocols for passive disease surveillance and training of pastoralists and other stakeholders in the recognition of priority diseases, disease reporting as well as research on the feasibility of alternative communication strategies for disease reporting such as free hot-lines and the use of mobile phones for disease reporting by pastoralists, CAHWs and others.

Wildlife surveillance

Effective wildlife surveillance in the post Rinderpest eradication era can be achieved through the establishment of a wildlife surveillance network with increase in the numbers of potential reporters and improved skills in recognition of disease syndromes and reporting. AU-IBAR, in partnership with national veterinary authorities, RECs, FAO, OIE and wildlife foundations, would prepare separate projects to create or improve comprehensive wildlife disease surveillance in Africa. While wildlife serology and pathogen surveillance are indeed rewarding, the current methods of trapping and sampling are complex and expensive. FAO and ILRI would be encouraged to investigateless expensive and more efficient methods as was suggested by Cameron (2010).

Participatory Disease Surveillance

Participatory disease surveillance utilizes a variety of interactive methods to enable stakeholders to share their knowledge and information on disease. This approach was found to be very useful for detecting syndromes in rural communities and is followed by systematic trace-forward and trace-back (Mariner and Roeder, 2003). It is very useful for disease data collection in remote, marginalised, pastoral and infrastructure poor areas. Although it is expensive and intensive compared to passive disease surveillance, it is considered an efficient compromise between the expensive structured sero-surveillance and poor targeting and low sensitivity of passive disease surveillance. It is equally

useful for the detection of disease syndromes and therefore should have a place in the proposed syndromic surveillance for the post eradication strategy in Africa. AU-IBAR in partnership with the RECs will prepare project documents on animal disease surveillance that will feature such activities as training of surveillance personnel on the use of PDS in syndromic surveillance.

Sero-surveillance

Structured livestock sero-surveillance that directly targets Rinderpest is not considered practical and sustainable because of the costs and logistic requirements. However, AU-IBAR would encourage Member States to broaden PPR surveillance objectives to include monitoring of the evolution of morbilliviruses. Samples collected as part of active, syndromic surveillance programs, especially those meeting the stomatis-enteristis case definition, should be tested for morbilliviruses.

Syndromic surveillance

The post-Rinderpest eradication era requires a surveillance system that is capable of monitoring trends in disease with important current impact as well as the emergence or re-emergence of evolving impact. This combination of objectives will assure that there are incentives to drive system implementation. Syndromic approaches to surveillance are an ideal approach to track both current and emerging disease problems. The system should be networked for exchange of disease information and requires a diagnostic network that ensures investigation of field surveillance results and confirms and shares the diagnoses with quality control and assurance. Most important transboundary animal diseases (TADs) that impact negatively on trade, food security and public health are fairly well known to most African livestock farmers including pastoralists. Local names and terminologies often refer to their symptoms or effects and any attempts to probe stomatitis-enteritis syndrome should be able to detect Rinderpest compatible events. AU-IBAR therefore proposes a new, comprehensive surveillance system that includes a syndromic surveillance programme designed to find and differentiate diseases which impact negatively on food security, restrict export trade of ruminant livestock and their products or have zoonotic implications.

Syndromic surveillance is guided by clinical case definitions built to capture a range of diseases that include key target diseases such as Rinderpest and other TADs. Both veterinary and non-professional observers can participate using open-ended interview processes followed by specific questions about the presence or absence of other clinical signs to be able to rule-in or rule-

out probable diagnoses (Cameron 2010). The proposed syndromic surveillance programme will not only support control of diseases affecting food security, export trade as well as important zoonoses, but also ensure vigilance regarding Rinderpest disease. Wider availability of pen-side tests for Rinderpest, morbilliviruses and other TADs would enhance the investigation of syndromic outbreaks and improve the efficacy of the surveillance in general. In the unlikely event of an outbreak, early warning, coupled with contingency plans and emergency preparedness (which includes immediate access to the vaccine in the AU-PANVAC vaccine bank) will enable rapid stamping out and return to a disease free status. AU-IBAR proposes the following four syndromes as cores for case definitions for the surveillance system:

1. Stomatitis-enteritis syndrome or Rinderpest-like conditions which include, besides Rinderpest, diseases that impact trade and food security such as PPR and FMD, and also MCF, IBR and BVD/mucosal disease included for differential diagnosis purposes.

2. A pneumonia syndrome to capture the pleuropneumonias (CBPP and CCPP) that affect trade and their differential diagnoses (pasteurella pneumonia, maedi visna and Jaagziekte).

3. An abortion syndrome to capture the brucellosis and RVF. With respect to these diseases, as well as having a major constraint on export trade, they are also important zoonoses and surveillance for these diseases will be important to human health as well as livestock health and trade.

4. Haemorrhagic syndrome which would include bovine haemorrhagic bowel syndrome, a sudden-onset, highly fatal emerging disease of calves associated with Clostridium perfringens type A, Bovine Calicivirus Enteritis and possibly EHD of sheep and cattle.

The technical content will be developed by AU-IBAR and its introduction to national veterinary services will be through AU-IBAR who will assume responsibility for backstopping the standards of surveillance over the next five years. Data management will be standardised and regional results will be used by AU-IBAR to determine regional disease trends and formulate control measures.

Improvement of post Rinderpest eradication surveillance systems

Overall, measures aimed at improving the above suggested post-Rinderpest

surveillance system to be implemented by national veterinary authorities include:

- National reviews of surveillance objectives and activities leading to a national surveillance plan that clearly articulates surveillance objectives and the integration of a balanced set of activities to meet these objectives.
- Integration of risk-based approaches such as participatory disease surveillance that will enhance the sensitivity of systems.
- Improving pen-side tests for morbilliviruses and other TADs as well as increasing their availability and application in routine surveillance.
- Strengthening the use of disease information databases and analysis within a GIS environment.
- Introduction of veterinary investigation protocols with defined sampling protocols.
- Use of participatory techniques in disease investigation to enhance and verify sensitivity of veterinary investigations and passive reporting.
- Defining and introduction of appropriate diagnostic algorithms with emphasis on cost effectiveness (including morbillivirus diagnostics).
- Institutionalization of risk-based, active surveillance in wildlife by mapping of wildlife populations and density, and identifying strategic surveillance and sampling sites.
- Conducting risk analysis on results of passive surveillance and on epidemiological and ecological information.
- Mapping livestock movements (pastoral and value chains) and, after the risk analysis, following up with targeted surveillance, including use of participatory disease search techniques to be preceded by a training programme to set up these procedures.
- Through IBAR, raising awareness of CVOs to the issues relating to the distribution of the trade related diseases and the need to maintain vigilance for Rinderpest.

CONTAINMENT AND ERADICATION

Contingency planning

Although most African countries had prepared country specific contingency plans for Rinderpest during the eradication phase, these plans would need modifications and updating to reflect the present state of global freedom from the Rinderpest virus.

National contingency planning

National Veterinary Authorities with technical support and guidance from AU-IBAR and in partnership with the relevant RECs will be expected to develop updated Rinderpest contingency plans which should contain a set of actions designed to prevent re-emergence of Rinderpest as well those to be taken in the unlikely event of an outbreak. Contingency plans should clearly articulate the actions to be taken to immediately contain focal outbreaks of Rinderpest, the resources needed and the chains of command and communication required for rapid implementation. Immediate international reporting of any suspected or confirmed Rinderpest events is essential. The starting point of plans should be from detection of suspected events and provide the procedure for provisional containment and diagnostic investigation leading to a solid diagnosis. Contingency plans should also describe actions to be taken in the event of a late detection or atypical morbillivirus outbreak that has spread from in initial focus by the time of recognition.

Such plans should describe steps to be taken to minimise to the barest minimum the number of animals to be slaughtered for disease control, reduce drastically the negative effect of control measures on food security and human and environmental welfare and minimise negative impact on food security, trade and tourism. National veterinary authorities in consultation with and assistance of the respective RECs would be required to solicit for the signing of emergency reserve bilateral agreements between various countries for the provision of veterinarians and technical experts in situations where individual countries may not be able to cope with such emergencies. It would be equally desirable to have continuing education in emergency preparedness and disease response as well as simulation exercises preferably organized through the RECs by AU-IBAR.

International contingency planning

Based on the results of the risk assessment of re-emergence of Rinderpest commissioned by FAO/OIE is expected to prepare a global contingency plan with a simple system for rapid response in case of any Rinderpest emergency, guidelines and procedures for procurement and use of emergency vaccines and well thought out vaccination strategies and diagnostic capability for a post-Rinderpest eradication era. AU-IBAR will work closely with FAO and OIE to develop appropriate standard training modules for application by Member States through national training courses financed within the scope of relevant project proposals to be prepared.

Awareness and sensitization sessions in Uganda for the vaccination against PPR and CCPP.

With regard to diagnostic capacity contingency planning, FAO is expected to designate International BSL3 Reference Laboratory/ies able to confirm and identify any morbillivirus recovered from a field situation. In addition, AU-IBAR will designate three regional diagnostic reference laboratories for Rinderpest and other transboundary animal diseases; one in West and Central Africa, one in East and the third in Southern Africa. Each reference laboratory will be incorporated in the OIE twinning programme and will exist as a centre of excellence with respect to the diagnosis and differential diagnosis of diseases causing stomatitis-enteritis (the condition to be identified by syndromic surveillance). The reference laboratories will work in conjunction with a network of national laboratories that will work with national surveillance teams providing them with primary diagnostic assistance and a source of material to be submitted for confirmation by the regional reference laboratory. Pen-side diagnostics for Rinderpest and morbilliviruses are needed as tools for first responders to stomatis-enteritis events. Positive results would raise the level of suspicion and result in strong incentives for immediate laboratory investigation. To address the probable threats of emerging morbilliviruses, within the proposed diagnostic capacity contingency planning, a collaborative

international morbillivirus discovery and monitoring programme should be established by the FAO-IAEA Joint Division in partnership with AU-IBAR reference laboratories and ILRI to ensure the existence of reference facilities and back-stopping to minimise the threat of failing to recognise the emergence of a new morbillivirus threat.

Coordination for integrated activities and rapid response

Effective management of TADs and zoonoses requires strengthened veterinary services at national level and cooperation among countries, the RECs and international organisations. With the eradication of Rinderpest, a clear goal that motivated regional coordination has been accomplished and it is feared that the political goodwill for sustained disease surveillance will dwindle. New shared objectives such as the progressive control of PPR (El-Sawalhy *et al.,* 2010) and enhanced regional participation in international trade need to be clearly articulated. The RECs have a role in the development and implementation of regional harmonisation and coordination mechanisms to enhance the capacity of AU Member States to prevent and control TADs and emerging diseases. This would in turn strengthen inter-regional and international trade in livestock and animal products, thus contributing to regional integration. Furthermore, enhancement of surveillance for trade limiting animal diseases as well as improvement of certification systems would enhance trade in livestock and livestock products at national and regional levels. At the level of enhanced production and food safety, regional coordination is needed to stop and roll back disease on the move such as CBPP and PPR.

AU-IBAR's partnership with international organisations like the FAO, OIE and IAEA was critical in the eradication of Rinderpest from the continent. Implementation of virus sequestration during the post-Rinderpest eradication era will be coordinated by FAO/OIE in the areas of transparent audit of Rinderpest virus holding facilities, guidelines for destruction of the Rinderpest virus and virus containing materials, disinfection of facilities previously holding the virus, development of new diagnostic kits, establishment of Rinderpest advisory committee and preparation of international contingency plans for dealing with possible Rinderpest emergencies.

Implementation of post-Rinderpest eradication era surveillance in Africa would be coordinated by AU-IBAR. This would be achieved within the AU-IBAR proposed Integrated Regional Coordination Mechanism for the prevention and control of transboundary animal diseases and zoonoses in Africa (IRCM). The initiative seeks to improve coordination among stakeholders involved

in the management of TADs and zoonoses in Africa, and establishment of critical competencies in the departments responsible for their prevention and control. It has a strong regional focus to ensure support for inter-country coordination besides addressing capacity gaps at country level, and support to the regional integration agenda spearheaded by RECs. The post-Rinderpest eradication disease surveillance features in projects proposed by AU-IBAR on Animal Disease Surveillance in Support of Trade in ECCAS, ECOWAS, GHA (IGAD and EAC) and SADC Member States. The morbillivirus surveillance activities proposed within the Pan African Strategy for the Progressive Control of PPR would provide a solid basis for post eradication surveillance and maintain institutional readiness in terms of management of infectious diseases. These projects are designed to improve animal health certification and traceability systems in the Region and to improve risk-based and syndromic surveillance targeting trade restricting diseases at national and regional levels.

The strategies on contingency planning in Africa will also be coordinated by AU-IBAR and will involve national veterinary services as well as various Regional Economic Communities (RECs).

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